SPATIAL DISTRIBUTION OF FUNGAL MATING-TYPE FACTORS.

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Higher fungi are usually recognized and identified by their aerial sporophores but such observations provide no information concerning the distribution and extent of their mycelia in the soil or wood in which they grow. If the sporophores produced by each mycelium possessed some distinctive feature it should prove possible to recognize the limits of an individual mycelium. The multiple-allelomorphic mating-type factors, characteristic of Hymenomycetes and Gasteromycetes, (Burnett 1956), seemed likely to be useful genetic markers for such an investigation and we have therefore studied their distribution in some species of both terrestrial and lignicolous Basidiomycetes.

Mating-type factors of a sporophore can be identified by a compatibility test. This is done by obtaining isolates, derived from uni-nucleate basidiospores, which are grown in pairs in all combinations in plate culture. Formation of a dicaryotic, clamp-bearing mycelium as a result of hyphal fusions indicates that the mating-type factors of the isolates under test are dissimilar. This technique has been used as part of a general investigation of the mating systems of fungi; those results which provide information on the spatial distribution of mating-type factors are reported here.

TABLE I

Fungus	Mating system	Size of sample (sporophores)	Habit and Location
Polyporus betulinus	Bipolar	30 and 23	Freshfield Lancs and Stravithie, Fife. Confined to Birch; 2 pops.
Corprinus comatus	"	17	Scattered; some clusters within a 10 ft circle. Terrest.
Collybia velutipes	Tetrapolar or variable	7	1 group of common origin; Terrestrial; U.St.A.B.G.
Polystictus versicolor	Tetrapolar	14	Closely agg. on stump Ladebraes, St. Andrews.
Hypholoma fasciculare	"	12 and 8	Scattered; some clusters. Terrest. U.St.A.B.G, 2 Coll. at 4 days apart

The species and populations studied are listed in Table I. Data for P. betulinus and C. comatus were obtained by Miss Margaret M. Saunders and J.H. Burnett (Saunders 1956 and in press).

RESULTS

Each mating-type factor was assigned a number when identified. Thus, the constitution of the sporophore of a bipolar species is here represented as $A_{n.m}$ or simply n:m, a tetrapolar form (mating-type factors at two loci A and B) by $A_{n.m}$ $B_{x.y}$ or simply n:m//x:y. The genetic formula for the spores of a tetrapolar species may be, however, either A_n B_x and A_m B_y or A_m B_x and A_n B_y.

(a) Polyporus betulinus

Table II summarizes the distribution of mating-type factors in trees where more than one sporophore was sampled. Fig. I represents the actual distribution of sporophores in Tree 7, Stravithie.

TABLE II

Mating-type factor constitution of sporophpres of Polyporus betulinus

Freshfield							Stravithie					
Tree No.							Tree No.					
1	2	3	7	8	9	10	1	2	4	5	7	12
1.2	3.4	2.10	3.16	4.10	1.6	8.9	7.9	1.5	3.6	2.17	3.8	4.15
3.9	5.6	4.12	14.15	4.10	10.17	4.7	7.9	1.5	2.8	2.17	3.12	4.15
	5.6	3.9	8.9		4.17	4.8	7.9	1.5	8.20		3.8	1,8
		2.11	14.15			7.19			8.10		4.20	
		2.11	3.16			10.19					4.20	
			8.9			2.11					9.10	
			8.9								3.8	
			10.17								4.20	
			8.9									

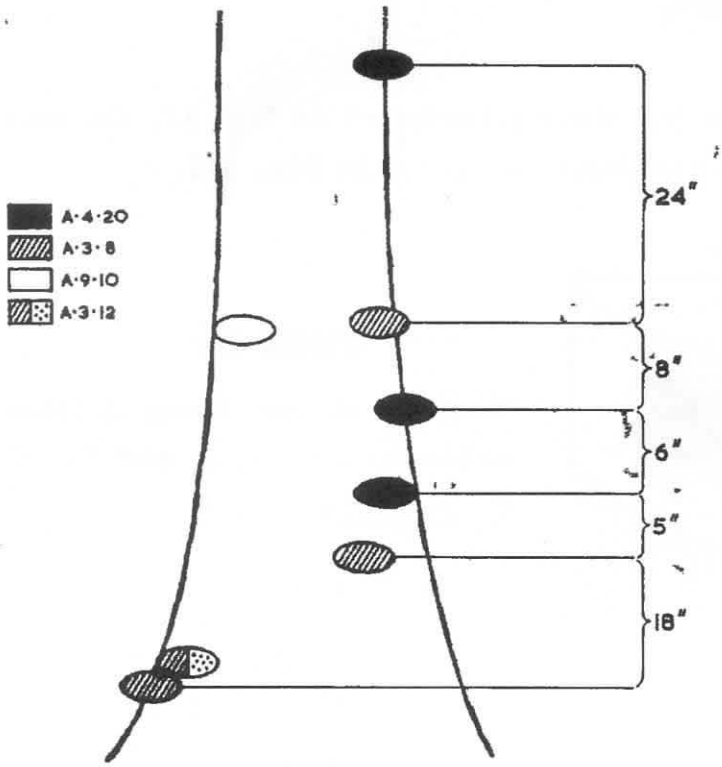


FIGURE I.

Constitution of 8 sporophores of P. betulinus on tree 7, Stravithie.

(b) Coprinus comatus

Sporophores which appeared to have a common basal origin are given the same number, e.g. 8a, 8b, etc.

TABLE III

Mating-type factor constitution of sporophores of Coprinus comatus within an area of 10 feet diameter

Sporophore number	1	2	5	6	7	8a	8b	10
Mating-type factors	1.2	2.3	4.–	3.5	6.7	6.8	9.–	5.–

Sporophore number	11a	11b	11c	11d	15a	15b	18a	18b	19
Mating-type factors	8.10	8.10	8.10	8.10	1.10	1.10	7.9	7.9	6.11

(c) Collybia velutipes

The 7 sporophores arose from a common basal origin and had identical constitutions of mating-type factors.

(d) Polystictus versicolor

The samples were taken from the sites illustrated in Fig. II, the constitution of the three groups of sporophores is given in Fig. III.

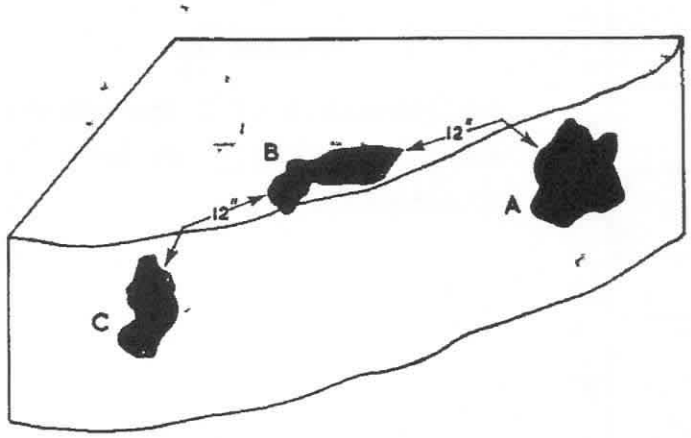
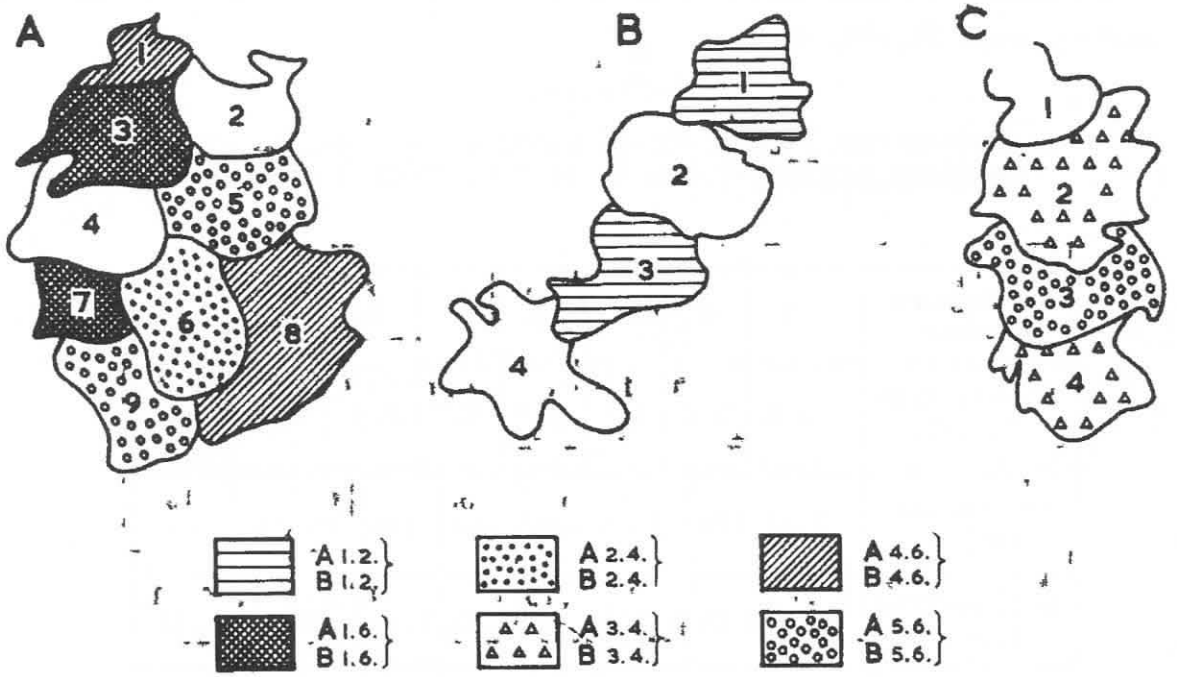


FIGURE II.

Location on tree stump of three collections, A, B and C, of P. versicolor.

FIGURE III.

Constitution of the sporophores of samples A, B and C, of P. versicolor.



(b) Hypholoma fasciculare

The location of the sporophores is shown in Fig. IV, those labelled I were collected on 19th August 1957, those labelled II on 23rd August 1957. The arabic numbers indicate the number of sporophores in each group sampled. All had the same constitution, $A_{1.2}\ B_{1.2}$.

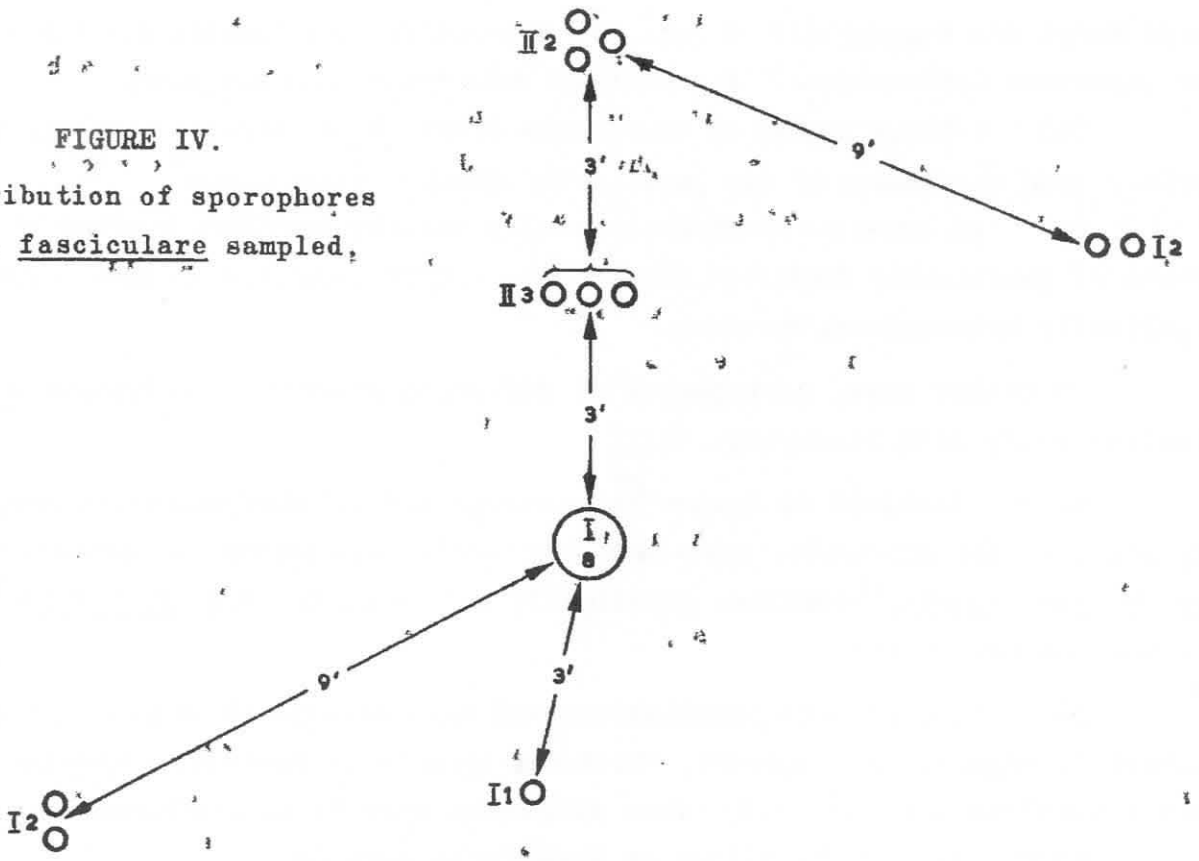


FIGURE IV.
Distribution of sporophores of H. fasciculare sampled.

DISCUSSION

The genetic constitution in respect of mating-type factors was the same, within each species, for the samples of C. velutipes and H. fasciculare examined. This is not surprising in C. velutipes where the seven sporophores appeared to arise from a common mycelial strand. A similar situation also obtained in three of the four clumps of C. comatus investigated. Evidently, in both these cases the sporophores were derived from a single, genetically homogenous, dicaryotic mycelium

In contrast the data concerning H. fasciculare may be interpreted in two ways. Either,

(a) there might be a single extensive mycelium which produces scattered clumps of and individual sporophores over a period of time

or (b) there might be a number of genetically identical mycelia with overlapping distributions, each mycelium producing single, or clumps of sporophores.

The distribution patterns of the mating-type factors in the other three fungi are susceptible of similar, alternative interpretations but there are important differences. The possible interpretations are either

(a) a large number of physically distinct, dicaryotic mycelia, each derived from the fusion of two genetically distinct monocaryons.

or (b) an extensive, physiologically unitary mycelium derived by the fusion of genetically different monocaryons and/or dicaryons to give a single genetically heterogenous mycelium.

In either case, sporophores of different genetic constitution arise simultaneously from dicaryotic cells.

We are inclined to favour the interpretation that extensive mycelia may occur in the substrate, sometimes genetically homogenous for mating-type, e.g. H. fasciculare, sometimes genetically heterogenous, e.g. P. versicolor, Our reasons are these:

1) The different permutations and combinations of mating-type factors in adjacent sporophores, which may even be in contact, is suggestive that a mycelium may fuse with other different mycelia at different parts of its periphery, e.g. P. betulinus on Freshfield Tree 19.

1.6 - 10.17 - 17.4

or P. versicolor group A Nos. 1,3,5,6,7,8 and 9.

Such fusions have actually been achieved by Miss Saunders in plate cultures of P. betulinus. The successful fusions are illustrated in Table IV.

It will be noted that fusions occurred between both genetically identical and genetically dissimilar, dicaryotic mycelia.

Fusions between dicaryons in plate culture of other Polyporaceae, including P. versicolor, have been observed by Robak (1942) and Cabral (1951)

TABLE IV.-

Successful fusions between mycelia of similar and different mating-type constitutions in P. betulinus.

Monocaryons x Monocaryons	Monocaryons x Dicaryons	Dicaryons x Dicaryons
1 x 3 x 4	1 x 1.4	1.2 x 1.2
	4 x 1.4	1.2 x 2.4
	3 x 1.4	1.4 x 2.3
		1.2 x 1.3

but without knowledge of the genotypes of the mycelia involved. Fusions of the three kinds investigated by Miss Saunders provide a basis for the observed distribution of genetically diverse, dicaryotic sporophores from a limited number of monocaryotic inocula.

2) Little is known of the control of sporophore production in Basidiomycetes (Hawker 1956). The simultaneous and synchronized development of closely aggregated, genetically differentiated, sporophores must be due either to a common external stimulus, if there are a number of distinct mycelia, or to a common internal stimulus if there is but a simple mycelium. In culture, different dicaryons of P. betulinus form hymenial pores at characteristically different times (Saunders 1956) and this is said to be the case in other fungi. Simultaneous production of sporophores by different dicaryons is, therefore, somewhat more likely if they are all developed from a physiologically unitary mycelium.

It has not proved possible to demonstrate in nature that hyphal fusions will produce a genetically diverse mycelium which forms a single physiological unit although an approach to this has been made in plate culture. Thus, at present, it is not possible to discriminate between the hypotheses we have presented to account for the spatial distribution of the mating-type

factors in the sporophores of the species investigated. It will be necessary to investigate further the properties of genetically heterogenous mycelia, in particular, their stability and physiological properties. This we hope to do.

If the hypothesis which we favour at present is correct the higher fungi will provide a unique model of the co-operative existence of different genetic entities within a species; a concept imagined but not investigated by Buller twenty-five years ago. (Buller 1931).

ACKNOWLEDGMENT

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